(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: METHOD AND SYSTEM FOR TRACKING ENGINE EMISSIONS AS A FUNCTION OF GEOGRAPHICAL LOCATION
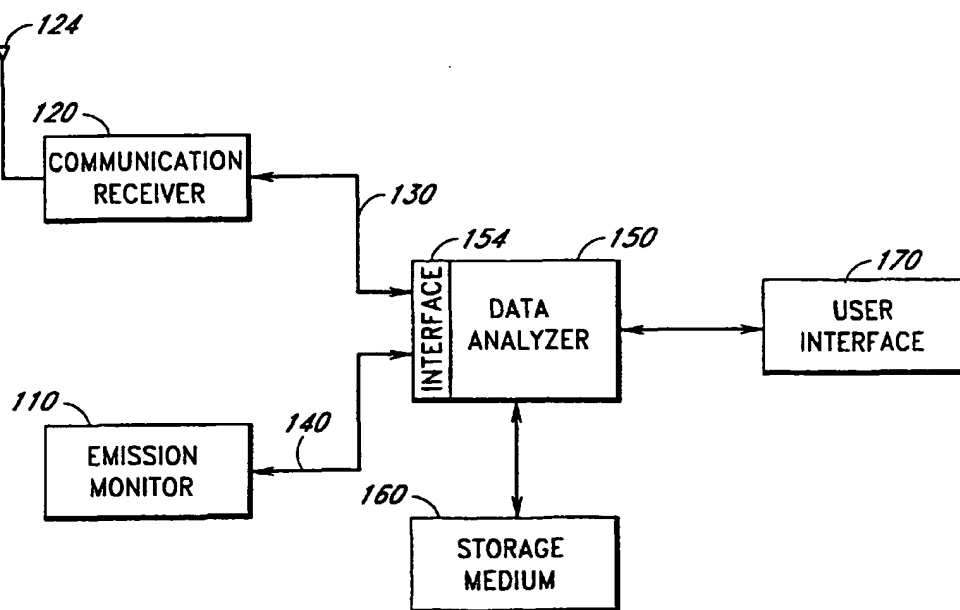
(57) Abstract: The invention provides a method and system for monitoring engine emissions of a moving craft, such as a ship. The system comprises a communication receiver that is configured to receive positioning data. The system further comprises an emission monitor that is configured to sense the opacity of an engine. The system synchronizes the acquired data, and displays to a user emission and positioning data on a monitor. The system allows storage of the acquired data in a storage medium as a record for later retrieval.

METHOD AND SYSTEM FOR TRACKING ENGINE EMMISSIONS
AS A FUNCTION OF GEOGRAPHICAL LOCATION

Background of the Invention

5   Field of the Invention

The invention relates generally to communication systems that provide a geographical location of a craft, such as a boat or ship. More particularly, this invention relates to a method and system for tracking engine emissions as a function of the geographical location of the craft.

Description of the Related Art

10   Environmental concerns have prompted global awareness to regulate and enforce rigorous emission control standards in various countries. For example, ships that navigate United States water regions are subject to compliance to strict engine emission standards, as specified by state and federal agencies, such as state agencies and the federal environmental protection agency (EPA). As ships navigate through international waters to other countries, emission regulations often vary from one country to another. Thus, ship personnel have to keep track of engine

15   emissions of their navigating ship frequently, as the ship moves in and out of regulated regions.

To keep track of engine emission levels, ships may be equipped with an emission monitor to detect sources of smoke and haze in engine emissions. An exemplary emission monitor includes the visible emission monitor, model DSM-1PM, manufactured by Optomonitor, Inc. However, as a ship moves through various water regions, there is no system or method of keeping track of engine emissions in relation to the location of the ship. In the event of an

20   alleged violation of emission regulations, ship personnel are unable to verify the occurrence or challenge the basis of the alleged violation. Any emission measurements collected by the emission monitor are often discarded, or simply not saved in a tangible medium. Moreover, even if such emission measurements are preserved, ship personnel are unable to correlate the measurements to the ship location when such measurements were acquired.

Therefore, there is a need in the shipping industry for a method and system for monitoring and recording

25   engine emissions as a function of geographical location. The system should provide real-time information, and allow storage of data for later retrieval.

Summary of the Invention

To overcome the above-mentioned limitations, the invention provides a system for monitoring engine emissions of a moving craft. The system comprises a communication receiver that is configured to receive positioning

30   data. The system further comprises an emission monitor that is configured to sense the emissions of at least one engine. The system further comprises a data analyzer that is configured to receive the positioning data from the communication receiver and emission data from the emission monitor. The data analyzer may be further configured to save in a storage medium and/or display on a monitor the positioning and emission data.

Another embodiment of the invention provides a method of monitoring engine emissions of a moving craft.

35   The method comprises receiving positioning data from a receiver, and receiving emission data from an emission

monitor monitoring the emissions of at least one engine. The method further comprises synchronizing the positioning and emission data as a function of time. The method also may display on a screen and/or save in a storage medium, the emission and positioning data.

Brief Description of the Drawings

5   The above and other aspects, features, and advantages of the invention will be better understood by referring to the following detailed description, which should be read in conjunction with the accompanying drawings, in which:

Figure 1 is a functional block diagram describing a system for monitoring engine emissions in accordance with the invention.

10   Figure 2 is an exemplary chart that displays information collected by the system of Figure 1.

Figure 3 is a flowchart describing one embodiment of the method of monitoring engine emissions as a function of geographical location in accordance with the invention.

Detailed Description of the Invention

Figure 1 is a functional block diagram describing a system 100 for monitoring engine emissions in
15   accordance with an embodiment of the invention. In one embodiment, the system 100 comprises at least one emission monitor 110 that may be installed on a moving craft, such as a boat or ship, to monitor smoke and/or haze in engine emissions. Typically, the emission monitor 110 includes a sensor (not shown in this figure) that directly measures the attenuation of visible radiation due to presence of particulate matter in the effluent of the engine (not shown in this figure). The system 100 may include several monitors 110, or a monitor having several sensors, to
20   monitor a plurality of engines. The measurement of opacity may be represented as the percent of light attenuated when particulate matter absorbs or scatters light passing through the effluent. In one embodiment, the emission monitor 110 may comprise the visible emission monitor, Model DSM-1PB, manufactured by Optomonitor, Inc.

The emission monitor 110 is connected to a data analyzer 150, such as a personal computer (e.g., IBM-compatible PC), to provide emission measurements (e.g., percent of light attenuation) to the data analyzer 150 via a
25   link 140. In one embodiment, the emission monitor 110 provides analog signals having a range of 0-5 Volts and 4-20 milliamperes (ma) to a signal interface 154, which is installed in the data analyzer 150. The signal interface 154 may comprise any commercially manufactured data interface card that is configured to receive measurement signals from the emission monitor 110 for analysis. For example, the signal interface may comprise a PCI-DAS1200 Series Multifunction Board for a peripheral component interconnect (PCI) bus, supplied by OMEGA Engineering, Inc. The PCI-
30   DAS1200 multifunction board is an analog and digital input/output (I/O) board that allows the data analyzer 150 to acquire data from the emission monitor 110 for analysis.

The system 100 further comprises a communication receiver 120 that communicates geographic data with the data analyzer 150 via a link 130. In one embodiment, the receiver 120 comprises a global positioning system (GPS) receiver that is connected to an antenna 124 to receive positioning data from a transmitting station (e.g., a
35   satellite, not shown). The positioning data may comprise information that includes the time of day, latitude, and

longitude of the location of the receiver 120. In one embodiment, the receiver 120 comprises a SVeeEight Plus GPS Receiver Module that provides positioning data to the data analyzer 150 via an RS-232 serial port. The communications receiver 120 may include a digital communication interface that conforms to Trimble Standard Interface Protocol (TSIP).

5   As noted above, the data analyzer 150 receives the emission data from the emission monitor 110 and positioning data from the receiver 120 for processing. In one embodiment, the data analyzer 150 continuously receives such data in real or near real-time. The data analyzer 150 typically includes a computer processor (such as a Pentium processor), random access memory (e.g., 128 bytes of RAM), and a hard drive (e.g., 13.6 Gigabytes) that is configured to store application software. The data analyzer 150 is typically equipped with a user interface 170. The

10   user interface 170 may include a keyboard, mouse, and/or monitor screen that allows a user to enter commands into the data analyzer 150, and review data acquired by the data analyzer 150 from the emission monitor 110 and receiver 120.

        In one embodiment, the data analyzer 150 includes a software application that is configured to control acquisition of data from the emission monitor 110 and receiver 120. In controlling the acquisition of data, the

15   software application may allow the user to specify several acquisition parameters, such as continuous, periodic (e.g., at predetermined time intervals), or on demand acquisition of data. Additionally, the user may specify several emission monitor and receiver operation parameters that are commonly associated with the operation of such devices. The software application may perform several data acquisition functions such as acquiring analog and digital signals, controlling external devices, real-time data analysis, communicate data to other application programs, and manipulate

20   signals. The software application may comprise a DASYLab data acquisition software that is modified to perform the functions specified in this disclosure.

        Additionally, the data analyzer 150 may include an internal or external data storage medium 160, such as a writeable read only memory (CD-ROM) drive. The data analyzer 150 may be configured to record acquired emission, latitude/longitude, and time of day information in the storage medium 160, which is dedicated to store a large amount

25   of data (e.g., several 100 Megabytes) for later retrieval. The availability of the dedicated storage medium 160 allows ship personnel to save a time-stamped record of the ship's engine emission data as a function of the ship's geographical location for an extended period of time (e.g., several weeks). Thus, in the event of an alleged violation of environmental regulations, ship personnel can retrieve a record that precisely identifies the ship's engine emission data, location, and time of data acquisition.

30   The data analyzer 150 is further configured to display the acquired data to the user in graphical form. Figure 2 is an exemplary chart that displays information collected by the system 100. The chart 200 includes an x-axis 210 that represents time of day divided into 5-second intervals. The chart 200 further includes a y-axis 220 that represents measurements acquired by the data analyzer 150 from the emission monitor 110 and receiver 120. In this embodiment, the y-axis 220 includes the following measurements: longitude 230, latitude 240, GPS time 250, and

opacity measurements 260, 270, and 280 (expressed as a percent of smoke) for engine number 1, engine number 2, and engine number 3, respectively. As indicated above, the measurements may be displayed in real or near real-time.

In one embodiment, the data analyzer 150 is configured to issue an audible or message alert in the event of any or some of the measurements exceed a predetermined threshold, or fall outside a specified range. More
5   particularly, when the opacity measurements of any of the engines exceeds a predetermined threshold, the data analyzer 150 may issue an alert signal to the user interface 170, to a supervisory computer, or to any other destination device via a modem. For example, when any of the opacity measurements exceeds a threshold of 30%, the data analyzer 150 may flash an alert message on the monitor screen to advise personnel that one or more of the engines may be generating smoke that exceeds the permissible range of applicable environmental regulations.

10 In another embodiment, the data analyzer 150 may be configured to activate the above-described alert function only within predetermined latitude and longitude values (i.e., within a specified geographical area). For example, the user may specify particular latitude and longitude values to activate the alert function when the ship is navigating the coastal regions of Alaska. Also, the user may specify particular latitude and longitude values to de-activate the alert function when the ship is navigating in unregulated waters. Accordingly, the user may selectively
15 configure the data analyzer 150 to specify measurement threshold values and/or geographic locations to activate alert functions, thereby customizing the system 100 to monitor engine emissions in response to various environmental regulations and territories.

Figure 3 is a flowchart describing one embodiment of the process of monitoring engine emissions as a function of geographical location in accordance with the invention. As shown in Figure 3, the process typically begins
20 at block 300 upon powering up the system 100, or running the application software. At block 310, the data analyzer 150 acquires positioning data from the communication receiver 120 via the link 130. When the communication receiver 120 is a GPS receiver, it may be necessary to convert positioning data from GPS format (e.g., absolute time) to conventional format (e.g., hours, minutes, and seconds). Most GPS receivers are capable of performing such format conversion. At block 320, the data analyzer acquires emission data (e.g., opacity measurements) from the emission
25 monitor 110 via the link 140. At block 330, the data analyzer 150 synchronizes the acquired positioning data with the emission data as a function of time. Such synchronization ensures that the acquired positioning data are timely matched with the emission data and, thus, both type of data correspond to a single reference time, e.g., GPS time or computer clock. The data analyzer 150 displays the data to the user via the user interface 170 as illustrated in Figure 2 above.

30 At block 340, the data analyzer 150 determines if a preset threshold of emission data and/or positioning data is reached or exceeded. If so, at block 350, the data analyzer 150 issues an alert signal or message to a desired destination, as described above. If no threshold is exceeded, the process proceeds to block 360 where the data analyzer 150 writes the acquired emission and positioning data into the storage medium 160 (e.g., a re-writeable CD-ROM) for later retrieval. At block 370, the data analyzer 150 determines whether further data acquisition is desired
35 by the user. Typically, the data analyzer 150 is set to acquire, display, and store data continuously. If so, the process

returns to block 310 where the entire process is repeated. If no further data acquisition is desired, the process terminates at block 380.

In view of the foregoing, it will be appreciated that the invention overcomes the long-standing need for a method and system that monitors and records engine emissions of a moving craft as a function of time and the craft's

5   geographical location. The system allows the user to record the acquired data in a storage medium for later retrieval. The invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiment is to be considered in all respects only illustrative and not restrictive.

10

WHAT IS CLAIMED IS:

1.   A system for monitoring engine emissions of a moving craft, comprising:

a communication receiver configured to receive positioning data;

an emission monitor configured to sense the emissions of at least one engine;

a data analyzer configured to receive the positioning data from the communication receiver and the emission data from the emission monitor; and

a storage medium connected to the data analyzer capable of storing the data received by said data analyzer.

2.   The system of Claim 1, further comprising a display monitor capable of displaying the data received by the data analyzer.

3.   The system of Claim 1, wherein the emission monitor measures the light attenuated by the emissions of the engine.

4.   The system of Claim 1, wherein the communication receiver is a global positioning system receiver.

5.   The system of Claim 4, wherein the communication receiver provides longitudinal and latitudinal positions and GPS time to the data analyzer.

6.   The system of Claim 1, wherein the data analyzer is a personal computer.

7.   The system of Claim 6, wherein the data analyzer synchronizes the emission data and the positioning data as a function of time.

8.   The system of Claim 1, further comprising an alarm when emission data exceeds a predetermined threshold.

9.   The system of Claim 8, wherein the alarm is an audible alarm.

10.   The system of Claim 8, wherein the alarm is a message alert displayed on the display monitor.

11.   The system of Claim 8, wherein the data analyzer uses specified positioning data to activate the alarm.

12.   A method of monitoring engine emissions of a moving craft, comprising;

receiving positioning data from a receiver;

receiving emissions data from an emissions monitor that monitors the emissions of at least one engine;

synchronizing the positioning data and emission data as a function of time; and

storing the positioning data and emission data on a storage device.

13.   The method of claim 12, further comprising displaying the positioning data and emission data on a display screen.

14.   The method of Claim 12, wherein the act of storing data includes correlating the positioning data and emission data.

15.   The method of Claim 12, further comprising generating an alarm signal when emission data exceeds a predetermined threshold.

16.   The method of Claim 15 further comprising using the positioning data to generate the threshold level of emission data required to generate the alarm signal.

17.   A system for monitoring engine emissions of a moving craft, comprising:

means for receiving positioning data from a receiver;

means for receiving emissions data from an emissions monitor;

means for synchronizing the positioning data and emission data as a function of time; and

means for storing the positioning data and emission data on a storage device.

18.   The system of Claim 17, further comprising means for of displaying the data received by the data analyzer on a display screen.

19.   The system of Claim 17, further comprising means for generating an alarm signal when emission data exceeds a predetermined threshold.

20.   The system of Claim 17, further comprising means for generating an alarm signal when emission data exceeds a predetermined threshold.

21.   The system of Claim 20, further comprising using the positioning data to generate the threshold level of emission data required to generate the alarm signal.
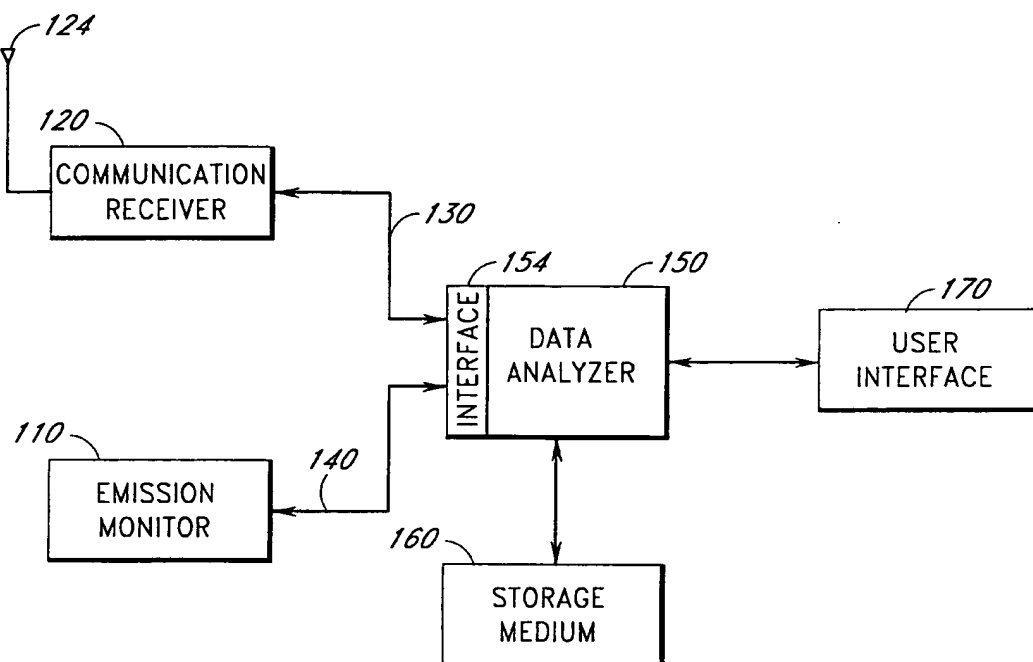
FIG.1

FIG.2

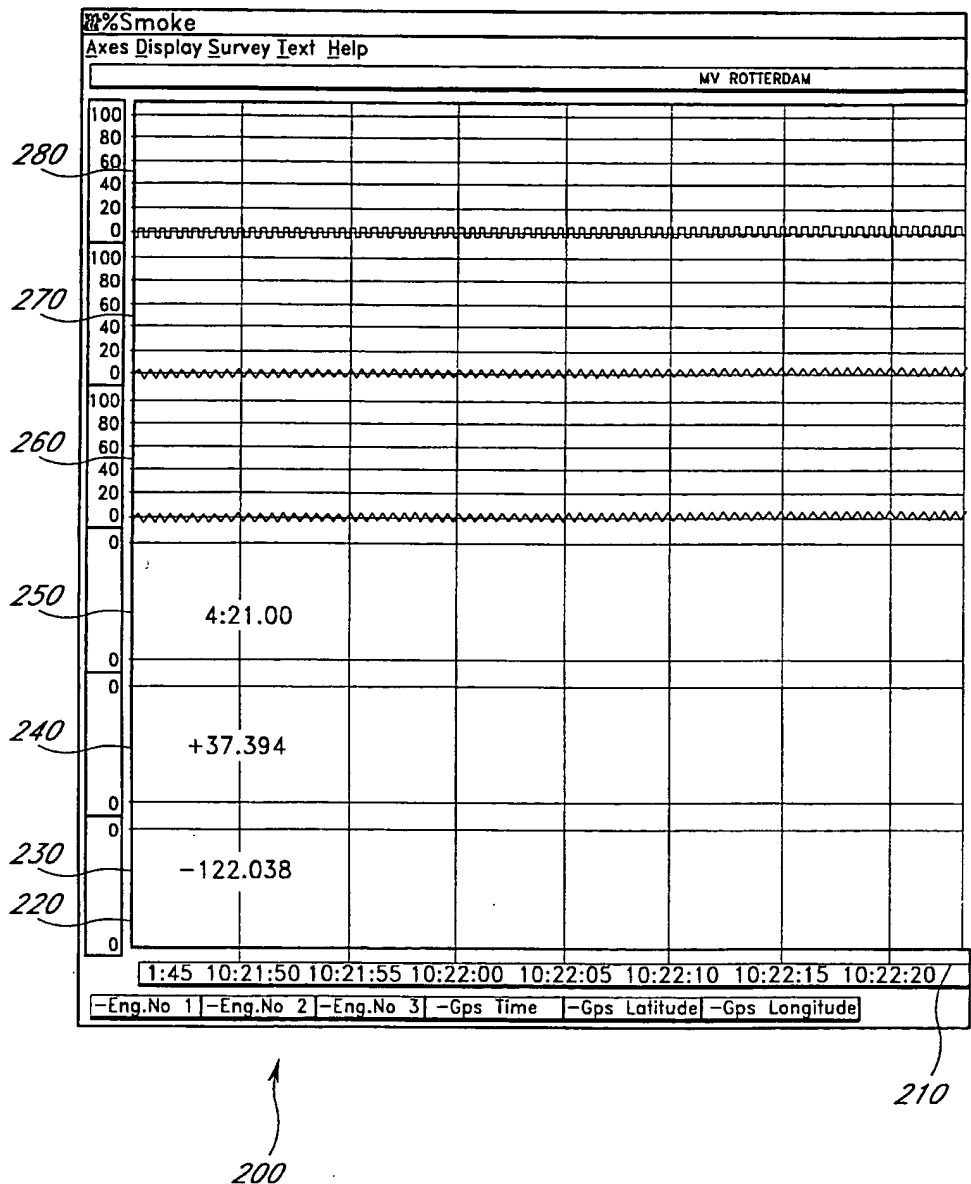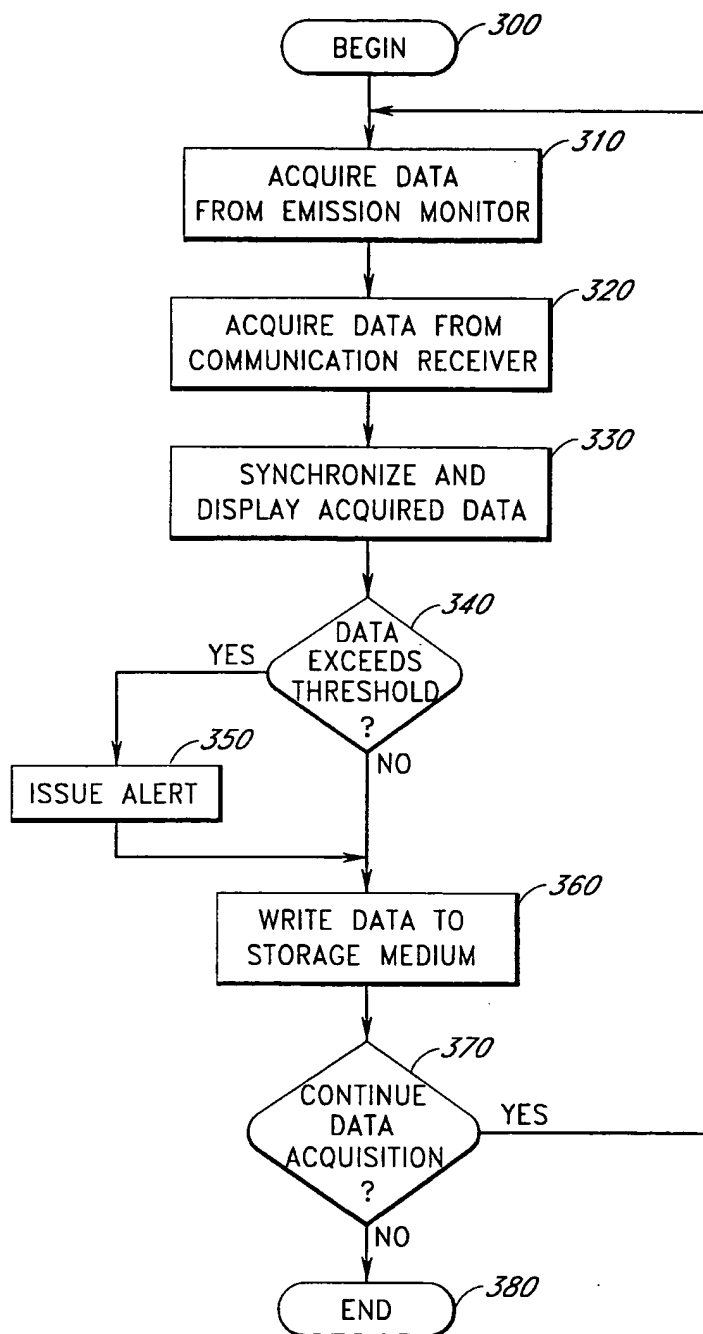**FIG.3**

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   G01N33/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	page 11, line 19 -page 19, line 3; figures	2-21
Y	WO 97 20167 A (REKUNYK HORACE) 5 June 1997 (1997-06-05) page 6, line 8 -page 15, line 20; figures	2-21
A	US 4 601 270 A (BULLIS ROBERT H ET AL) 22 July 1986 (1986-07-22) abstract	8,11,15, 16,19-21
A	EP 0 471 074 A (SRED AZ NI I PI TSVETNOI METTA) 19 February 1992 (1992-02-19) column 3, line 25 -column 7, line 36; figures	3

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[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2001	30/05/2001

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Internatic Application No

PCT/US 00/34512

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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